October 3, 1975

RECYCLING OF OLD CROSSTIES FOR INDUSTRIAL FUEL

by

Thomas W. Church, Jr.
Principal Market Analyst

Northeastern Forest Experiment Station
Forest Products Marketing Laboratory
Princeton, West Virginia

Northeastern Forest Experiment Station
U.S. Forest Service, Dep. of Agriculture
6816 Market Street, Upper Darby, Pa.

October 3, 1975

RECYCLING OF OLD CROSSTIES FOR INDUSTRIAL FUEL

by

Thomas W. Church, Jr.
Principal Market Analyst

Speech to be presented at the RTA Convention at Roanoke, Virginia, on October 15 - 17, 1975

REFERENCE ABSTRACT

Church, Thomas W., Jr.

1975. Recycling of old crossties for industrial fuel. USDA For. Serv. Res. Pap. NE-__, __ p.

With recent environmental restrictions, the disposal of old crossties has become a major problem for railroads. Because of the energy crisis, the problem can be transformed into an opportunity. Old crossties can be converted into nonpolluting industrial fuel. A recent study indicated that the costs of recycling old ties are less than the dollar returns from burning them. Railroads can expect a net income of about $1 per tie by using this fuel in their own facilities or selling it to trackside customers. Nationally, the combustion of old crossties will conserve the equivalent of 1 million tons of coal or 4-1/2 million barrels of oil per year.

OXFORD: 831.6 - 839.81

KEYWORDS: CROSSTIES, BOILER-FUEL, ENERGY-CONSERVATION, MATERIALS-HANDLING, MARKET-ANALYSIS

INTRODUCTION

Paraphrasing General MacArthur's farewell speech to Congress, railroad trackmen could say--old crossties never die, they just fade away. But they fade away very slowly. So, unless physically removed or destroyed, millions of old ties accumulate along railroad rights-of-way each year.

You know why these tie accumulations are detrimental. They create fire and safety hazards; they block drainages; they look bad; they increase the opportunity for trespass; and they might contribute to the pollution of water on adjacent properties.

The disposal of old crossties has only become a major headache within the last 10 to 15 years. Prior to 1960, old ties could be burned in place or handled for a relatively low cost. Now, environmental regulations prohibit most open burning. And, costs have escalated for traditional disposal methods like burial, mechanical shredding, or delivery to tie dumps. Consequently, most ties are being left along the right-of-way thereby creating the problems rail officials must cope with.

THE SOLUTION

Why not transform the tie disposal problem into an opportunity? An opportunity for what? To make money. Can all old ties be converted into cash? They certainly can--provided they are sound enough to withstand loading and shipment. What is the product? Industrial boiler fuel. Where are the markets? Railroad car shops, crosstie treating plants, or major on-line industries like papermills or grain processing plants.

What is the association between the fuel needs of the railroads or treating plants and the tie disposal problem? It's really a hand-to-mouth relationship. Railroads have a waste product with a high energy potential and they need boiler fuel. Most railroads heat repair shops, offices, hotels, and other major structures. Treating plants need steam for pumping, pressurizing, evaporating, and impregnating. With proper distribution, the railroad and treating segments of the tie industry might consume all available ties. So, my question to you gentlemen is: Why burn gas, oil, or coal when you can use a product you now throw away?

RESOURCE AVAILABILITY

The quantity of old ties available for fuel can be directly linked to the number of new ties installed. Crossties publishes a list of tie replacements for each railroad. So, we can assume that nearly all of the ties removed would be available for fuel if they were properly placed by tie removal gangs and promptly picked up before trespassers pilfer them.

In 1973, 18 million ties were replaced by Class I railroads. The 1974 figures should show at least 20 million replacements. Removals will be lower as long as the recession lasts. But with economic recovery, we can count on an annual supply of about 22 million old ties. Replacements might even be greater as railroads strive to catch up with deferred track maintenance.

For a more meaningful assessment of tie resource availability, numbers should be converted to weight. This transformation is desirable because heat values can be expressed in universally accepted terms such as B.t.u.'s per pound. And business transactions will most likely be based on weight.

What does an annual supply of 22 million old ties mean in terms of weight? About 2 million tons. How did we make that conversion? From the results of a tie weight study that showed the average crosstie removed from track weighed about 190 pounds.[1/]

What does this volume of 2 million tons mean in terms of rail traffic? Well, it means an additional yearly rail haul of at least 65,000 carloads. This extra nonrevenue freight might disturb railroad operating departments. And the proposed shipment of old ties in gondolas might annoy tie producers or treating plant operators now faced with car shortages. Let me expel your fears. We believe most of the old ties can be carried in the same cars that you shipped the new ties in. So, the hauling of old ties should not create any major difficulties in traffic or car availability.

HEATING POTENTIAL

Now that we have estimated the annual tie resource to be 2 million tons, we need to know how much heat we can get from this supply of old ties. Our experiments in heat determination revealed that the average eastern hardwood tie removed from track had a gross heat of combustion of 6,740 B.t.u. per pound. From the 132 samples used for this heat determination, we found the average moisture content was 24 percent, wet basis. When the moisture was driven off from another group of 132 paired samples, the average oven dry heat of combustion was 8,650 B.t.u. per pound.

The preceding figures on heat of combustion were developed from scientifically approved techniques used in our specially equipped crosstie laboratory. Tests were run on chips from auger holes bored at seven identical locations across the upper and lower faces of each tie. We frequently found heat differences of 1,000 B.t.u. per pound within a tie: most of them due to moisture content. In fact, the range of heat yields within a tie were often greater than differences in heat yields between ties representing a variety of ages, track conditions, or sampling sites.

Now let's project these individual findings to a national scale. Assume that 2 million tons of old ties can be used for industrial fuel each year. Incineration of these ties could replace the annual consumption of:

A. Coal -- 1 million tons

B. Oil -- 200 million gallons, the equivalent of 4-1/2 million barrels.

Do these quantities interest you? If not, they certainly should appeal to potential customers on your lines that face shortages of traditional fossil fuels.

HANDLING AND PROCESSING METHODS

Since most of you men are interested in the practical aspects of this potential market, let me describe some of the problems that you will have to face.

LOADING

Tie pickup can be one of the most time-consuming and expensive phases of the whole fuel preparation sequence. If your ties or tie blocks have been indiscriminately scattered along the right-of-way, loading costs will be much higher than if the ties have been piled. Our observation of tie gangs revealed that the grapple operator usually has ample time to pile individual ties or butts without delaying any part of the mechanized operation that follows this function.

Time studies showed an average 20-second cycle for picking up three sections of each tie, placing them along the right-of-way, then moving into position for the next group. On some crews, there is enough time to stack tie butts in neat oriented piles. This neat stacking will help reduce subsequent loading time because more pieces can be grasped at one time by the crane used to load the old ties.

To get some idea of loading requirements, we conducted some tests under actual operating conditions. We loaded two gondola cars of tie butts with a self-propelled, rail-mounted crane equipped with a 50-foot boom and clamshell.[2/] The first carload of about 980 tie blocks was loaded in exactly 1 hour. This test represented heavy replacements of about 900 ties per mile. Piles of jackstrawed tie butts contained about 21 pieces each and were spaced about 43 feet apart. The second carload of 915 tie blocks was loaded where replacements averaged only 270 ties per mile. For this test, there were only 13 pieces in piles spaced 87 feet apart. Because of the smaller piles and greater spacing, loading time required 1-1/2 hours per car.

Under the conditions studied, the tie crane and crew only had about 50 percent availability. The loading unit would have to run to the nearest siding when two cars were filled. Then the loaded cars would have to be switched onto the siding and empties picked up. Heavy traffic reduced productive loading time even further. Our records indicated that only four cars per day could be loaded with the tie replacement methods and traffic conditions studied.

To speed up loading and reduce costs, we suggest that specialized equipment be developed. For example, the Lucky Manufacturing Company[3/] has designed a special knuckle-boom crane for loading full length ties or butts. This crane has been engineered to run along the top of gondola cars. Retractable bridging and guide wheels allow the crane to cross between cars. With this arrangement, a trainload of 8 or more cars could be loaded without switching. Obviously, production should be greater with this unit. It could also be used to unload new ties if proper train schedules could be worked out.

HAULING AND UNLOADING

We conceive of a handling system that incorporates the use of designated tie cars for returning the old ties to a central processing site. If a railroad has a fleet of specially designed tie cars, they might not be suitable for hauling short tie blocks. For this situation, old ties could be taken out whole and loaded for the return haul with special equipment. Otherwise, standard gondolas could be used.

The primary consideration in hauling the old ties is not car type, but destination. Logic suggests that the cars of old ties should be routed back to the treating plant from which they came. I know that you treating plant managers might quiver at that proposal in view of recent space limitations during peak production. But think of the advantages.

If old ties were returned to the treating plant and processed there, they could become a source of fuel for your buildings and cylinders. You could feed existing or modified boilers directly from adjacent tie disintegration units. Long-term contracts would stabilize fuel costs and guarantee adequate supplies. The cars for outbound black tie shipment would be right where you want them. Costs of additional trackage and switching facilities could be handled in the pricing negotiations with the consumer railroads. And, the bond between the treating companies and the railroads would be cemented more firmly because of extra mutual investments made.

The unloading process should be simple and cheap. A standard grapple crane could be set up near the infeed conveyor of the tie disintegrator. Cars could be moved past the unloading crane either with a small switch engine or a car puller.

We have not completed our time studies of the unloading phase. However, we believe that carloads of tie butts can be unloaded at least as fast as they can be loaded. So even with the less efficient clamshell crane, we can expect a maximum unloading time of 1 hour per car. On a weight basis, ties could be unloaded at a rate of 25 to 30 tons per hour.

SHREDDING AND HOGGING

To make old ties acceptable for boiler fuel, they must be reduced to small particles. Manufacturers of new types of waste wood incinerators would like to have fragments no greater than 1 inch cube. However, in one of our preliminary tests, we used a hogged tie sample containing some pieces up to 3 inches long and nearly 1 inch thick with no adverse results.

Since ties must be fragmented for efficient combustion, you have two alternative processing sites and methods. You can use a specially adapted rail-mounted tie destroyer that picks up ties and hogs them as it proceeds through the tie replacement zone. Or, you can load full-length ties or tie blocks into cars and haul them to a central processing site. We favor the latter system and have made a rather intensive appraisal of centralized processing.

Our evaluation of centralized tie processing revealed the following needs: (1) A well-drained breakdown and storage site of at least 5 acres to handle the temporary retention of 400 carloads of old ties, shredded tie fragments, trackage, and processing equipment; (2) a source of power (preferably steam to run the main shredder) plus electricity for conveyors and separators; (3) an on-site outlet like a treating plant that can consume at least one-fourth of the hogged fuel for their own processes; (4) a railroad investment of about $1/2 million for the combination of machinery needed to unload, shred, screen, hog, pile, and load the processed fuel; and (5) a treating company investment of $300,000 for special incinerator and boiler.

Companies like Hammermill[4/] make shredders that will easily handle up to 50 tons per hour. In fact, we have already run tie block samples through a Hammermill Bulldog Shredder at the rate of 20 tons per hour. And we were limited by the speed of intermittent feeding for a unit set up to disintegrate solid waste at the Harrisburg, Pennsylvania, municipal disposal facility.

Although high capacity shredders can apparently run with little downtime, they do not produce the size or shape of particles most suitable for self-feeding wood incinerators. So, supplemental disintegration will be required. Hogs like those made by Montgomery Industries[5] can reduce irregular fragments from shredders to nearly uniform particles. The smaller more uniform particles allow metering devices to supply a flow of fuel consistent with heat demands.

COMBUSTION TECHNIQUES

The new fluidized bed incinerators seem to be well suited to the combustion of hogged railroad ties. We ran about a ton of tie fragments through York-Shipley's[6/] F-B-50 Solid Waste Converter in York, Pennsylvania. Half of the sample represented 40 - 50 year old ties that had been out of track nearly 2 years. The remaining ties came from 20 to 30 year old ties just removed from service.

The results of this preliminary test were very encouraging. Tie particles from both samples burned with practically no visible stack emissions. Combustion chamber temperatures varied slightly around a constant mean of 2100°F. And, boiler output ranged from 3,450 to 3,700 pounds of steam per hour.

York-Shipley manufactures fluid bed incinerator boiler package combinations with a boiler output range of 4 million to 60 million B.t.u. per hour. If your maximum hourly requirements are about 20 million B.t.u. or 20 thousand pounds of steam, you will need a combination incinerator and 580 horsepower boiler plus fuel metering system costing about $300,000. If you or your customers need an incinerator to supply existing boilers with up to 40,000 pounds of steam per hour, the unit and feed system will cost about $1/2 million. The approximate prices for both units mentioned above include automatic bed cleaners to rid the incinerator of foreign material like ballast and metal.

Although the early trial looked favorable, there was still some question if particulates or invisible noxious fumes were being vented from the stack. Accordingly, Mr. Coxey of the AAR and Mr. Dolby of the ICG Railroad arranged for a precise stack emission analysis in cooperation with York-Shipley. They contracted with the Roy Weston Company to evaluate a run of hogged tie fragments to see if stack gases met EPA acceptance standards.

The final report on the results of this day-long test had not been received when this paper was written. Yet, the preliminary indications appear favorable. At full operating temperature, stack gas analysis showed no hydrocarbons and no oxides of nitrogen. We expect that particulates and SO^2 levels will also be acceptable.

ECONOMIC CONSIDERATIONS

The decision to use hogged crossties for industrial fuel will hinge on its cost in relation to the cost of an equivalent heat output from traditional fossil fuels. Shortages of natural gas and oil may induce some industries to consider substitutes like hogged ties. But corporate decisions will be based primarily on dollars per million B.t.u.'s and secondarily on abundance or assurance of supply.

How much are hogged crossties worth? From a gross fuel value standpoint, the following relationships for delivered fuels appear reasonable:

Type and Cost of Existing Fuels	Gross Value of Hogged Ties at Burner
Coal at $50 per ton	$25 per ton
No. 2 oil at 35¢ per gallon	$35 per ton
Natural gas at $1/M cubic feet	$12.25 per ton

Be certain that you don't use the above figures as the true value of hogged tie fuel. Remember that you or your potential customers will need to make sizable investments to convert existing boiler facilities into smokeless, efficient tie burners. And, railroads will have a substantial cost for collecting, processing, and delivering the fuel. So, tie fuel would have a much lower comparative value than the figures in the preceding tabulation would indicate.

Furthermore, if you sell hogged fuel to industrial customers, you will likely have to accept a price even lower than its true value. Why? These businessmen know you are marketing a waste product--material you really must dispose of. Thus, they will conclude that the bargaining price should be set low enough to allow for their combustion investment and to cushion any difficulties arising from the use of a new fuel.

To obtain a good estimate of hogged tie values, we will have to work with a set of specific conditions. Selling price depends upon so many factors that a different value would have to be developed for each railroad. So, let me describe circumstances that represent the approximate cost-price relationships for one of our major eastern railroads.

Here are the basic premises used to compute the net value of tie fuel on two regions of the Norfolk and Western Railway:

1. Centralized processing at treating plant.
2. Tie butt inhaul and hogged tie outhaul averaging 100 miles.
3. Annual volume processed of 52,000 tons: 210 tons per day, 250 days per year.
4. Total railroad investment of $1,500,000 for two intermediate-sized incinerator package boilers, one larger incinerator, one complete shredding complex, and two hydraulic grapple cranes.
5. Treating company investment of $300,000 for a package waste converter and boiler to provide process steam for tie preservation and shredder turbine.
6. Tie block loading, hauling, and unloading cost of $5.25 per ton.
7. Shredding and hogging cost of $2.50 per ton.
8. Loading coal hoppers, hauling to railroad shop facilities, and unloading into storage for $2.25 per ton.

9. Total processed cost of $7.75 per ton and total delivered cost of $10 per ton.

10. Sale of processed fuel to treating plant at $10 per ton.

Now, let's apply these basic premises and cost data to existing situations on the N&W Railway:

Situation A.--Two car plants burning a total of 11,000 tons of ties versus 1,028,000 gallons of oil. Annual net savings from ties = $204,000 or $18.50 per ton.

Situation B.--One major shop, repair facilities, and central offices burning 22,200 tons of processed ties versus 11,100 tons of coal. Annual net savings from ties = $325,000 or $14.60 per ton.

Situation C.--Sale of 17,000 tons of hogged fuel to treating plant at central processing complex for $2.25 per ton above the $7.75 per ton costs. Annual net income of $38,000.

All Situations.--Consumption and sale of 52,000 tons of processed ties gave a net annual income before taxes of $567,000. Thus, the average net value of processed tie fuel was $10.90 per ton. With 10-1/2 ties per ton, each tie would have a net value of about $1.

C A U T I O N!

The preceding figures apply only to the specific conditions studied on the N&W Railway. So, the values cannot be transferred: each railroad will have to work out its own analysis. For example, processed tie fuel can vary by $2 per ton with only a 500 B.t.u. per pound difference in tie heat output due to moisture content. Or, a difference in loading technique could also change net tie value by $2 per ton.

Meanwhile, back at the treating plant, what financial returns can company officials expect from their $300,000 investment? Let's assume that the plant burns a combination of natural gas and oil. Gas costs 95¢ per thousand cubic feet and oil costs 32¢ per gallon. Now, examine two situations relating to different fuel mixtures as they are influenced by seasonal availability. How do they influence the economics of burning ties?

Situation A.--Warm season use where 90 percent of the heat comes from natural gas and the remainder from oil. Cost of burning traditional fuels is $235,000 per year. Cost of burning 17,000 tons of processed ties to obtain an equivalent heat is $198,000 per year. Annual net savings from ties = $37,000. So, ties are worth about $2.20 per ton.

Situation B.--Cold season use where natural gas supplies have been cut in half and the remaining heat demands are supplied from oil. Cost of burning this mixture is $410,000 per year. Combustion costs for processed tie fuel remain the same: $198,000 per year. The annual savings from burning ties = $212,000, thereby giving ties a net value of $12.50 per ton.

Combined Situations.--Consider a 6-month's consumption of traditional fuel at each of the rates and costs stated above. Substitution of processed tie fuel would provide an annual savings of $124,000. Thus, ties would have a net value above the $10 delivered cost of $7.30 per ton.

MILLIONS FOR BOILER FUEL BUT NOT ONE CENT FOR DISPOSAL

The problem of old crosstie disposal can be solved by recycling this material for industrial boiler fuel. Existing energy shortages and escalating costs guarantee the success of this venture. You simply cannot afford to abandon or throw away old ties when they have heat yield ratios of 1:2 for coal and 1:2.8 for oil.

Consider these facts. Old ties can be burned without visible stack emissions or harmful concentrations of noxious fumes. Ties can be picked up and hauled to a central processing site for about $5 per ton. Existing equipment can shred and hog up to 50 tons per hour for a cost of $2.50 per ton. Screened tie fragments can be delivered to markets 100 miles away for about $10 per ton. Tie fragmentation can be performed at treating plants where one-fourth or more of the fuel can be used to furnish the entire heat and steam requirements. And, cars used for old tie return can be loaded with new ties without deadheading.

Railroad and treating company officials should carefully analyze each specific situation before deciding upon a course of action. Investments for special fluid bed incinerators, tie shredders, storage areas, and modified loading equipment will run above a million dollars. And, if railroads use their waste ties to heat their own facilities, investments might exceed $1-1/2 million.

Compare these investments with expected returns and you will see that the expenditures are worthwhile. Our analysis for the N&W Railway showed a <u>net</u> return of about $11 per ton before taxes. So, the conversion of about 50,000 tons of old ties into useful boiler fuel provided an annual income of about $550,000. Furthermore, the treating plant, collaborating in this venture, would receive an annual net income of about $125,000 from using ties rather than traditional boiler fuel.

Using this concept, everyone gains. The railroads don't spend a cent for disposal but reap hundreds of thousands of dollars from fuel use or sales. The treating companies save money and stabilize their fuel sources and prices. The American public has an extra million tons of coal or 4-1/2 million barrels of oil to divert elsewhere each year. And, the railroad rights-of-way are cleaner and safer. How about a green signal for converting your old ties into boiler fuel!

FOOTNOTES

1. Church, Thomas W., Jr. and John W. Pearce. Weights of crossties removed from service. 1975. (In preparation for publication in CROSSTIES magazine).

2. These loading tests performed by an experienced railroad crew.

3. Identification of manufacturer's brand does not constitute endorsement by the Forest Service.

4. Ibid.

5. Ibid.

6. Ibid.